ACCESSION #: 9611220125
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Sequoyah Nuclear Plant (SQN) Unit 2 PAGE: 1 OF 10

DOCKET NUMBER: 05000328

TITLE: Manual Reactor Trip, as a Result of an Unexpected Loss of
Load, with Feedwater Isolation and Auxiliary Feedwater
Start
EVENT DATE: 10/11/96 LER #: 96-005-00 REPORT DATE: 11/12/96

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 47

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: J. Bajraszewski, Compliance TELEPHONE: (423) 843-7749
Licensing Engineer

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: JI COMPONENT: PS MANUFACTURER: A502
X SJ BRK D175
REPORTABLE NPRDS: Y
Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On October 11, 1996, at 0827 Eastern daylight time, with Unit 2 in power operation at approximately 47 percent, manually tripped as a result of an unexpected loss of load. Before the unit was tripped, operators a controlled unit shutdown. The shutdown was initiated because of low No. 1 seal return flow on the No. 4 reactor coolant pump. The unit shutdown was progressing as expected up through removing the "B" feedwater pump from service. After the pump was removed from service, Operations personnel determined that a turbine runback was in progress and that the auxiliary feedwater system had started. In response to the unexpected runback (loss-of-load) condition, the operator at the controls tripped the reactor. Subsequent to the reactor trip, a feedwater isolation occurred and Operations personnel observed the loop No. 4 feedwater

isolation valve lose control room indication. Post trip evaluations determined that malfunction of the turbine impulse pressure switches resulted in the turbine runback condition. The loop No. 4 feedwater isolation valve failed to travel to the closed position because the valve's position retention brake did not release. The cause for the failure of the pressure switches resulted in the turbine runback condition. The loop No. 4 feedwater isolation valve failed to travel to the closed position because the valve's position retention brake was corrosion product buildup as a result of water intrusion. The pressure switches and the feedwater isolation valve motor and brake assembly were replaced, tested and returned to service. The root cause of the event was inadequate field inspection and corrective action for the water intrusion events. Lessons learned from the event were communicated to appropriate site personnel.

END OF ABSTRACT

I. PLANT CONDITIONS

Unit 2 was in power operation at approximately 47 percent with a unit shutdown in progress.

II. DESCRIPTION OF EVENT

On October 11, 1996, at 0827 Eastern daylight time (EDT), the reactor was manually tripped as a result of an unexpected loss of load. Before the unit was tripped, operators were performing a controlled unit shutdown. The shutdown was initiated because of a low No. 1 seal return flow [EIIS Code CB] alarm on the No. 4 reactor coolant pump [EIIS Code AB]. The unit shutdown was progressing as expected up through removing the "B" feedwater pump [EIIS Code SJ] from service. After the pump was removed from service, Operations personnel determined that a turbine runback was in progress and that the auxiliary feedwater system had started. In response to the unexpected runback condition (loss-of-load), the operator at the controls tripped the reactor. Subsequent to the reactor trip, a feedwater isolation occurred and Operations personnel observed the loop No. 4 feedwater isolation valve lose control room indication. During the transient, operators were unable to take manual control of the auxiliary feedwater motor-driven pump level control valves to prevent excessive reactor coolant system (RCS) cooldown. Therefore, after verifying adequate steam generator levels, the main control room (MCR) operators placed the motor-driven auxiliary feedwater (MDAFW) pump controls in the pull-to-lock position. Steam generator

levels were maintained by manual operation of the turbine driven auxiliary feedwater (TDAFW) pump level control valves. Post trip evaluations determined that malfunction of the turbine impulse pressure switches resulted in the turbine runback condition and inability to take manual control of the MDAFW pump level control valves. It was also determined that the loop No. 4 feedwater isolation failed to travel to the closed position. The feedwater regulator valves closed as designed to isolate feedwater flow.

B. Inoperable Structures, Components, or Systems that Contributed to the Event:

A unit shutdown was being performed in response to low No. 1 seal return flow on the No. 4 RCP. Abnormal operating procedures required the No. 4 RCP to be removed from service within eight hours of receipt of the low flow alarm. Subsequent to the reactor trip, it was determined that the loop No. 4 seal return, air-operated, flow control valve had traveled to the closed position. This resulted

in the loss of seal return flow and an increase in seal flow from the No. 2 seal leakoff. The flow control valve traveled to the closed position because the valve's air flow solenoid valve had failed. The solenoid valve failure allowed control air to bypass the solenoid valve's o-rings. This resulted in air being provided to both the operator of the seal return flow control valve (causing the valve to travel to the closed position) and the solenoid valve's exhaust port. The solenoid valve failure was caused by thermal age hardening of the valve's o-rings because of the valve being exposed to elevated temperatures. The solenoid valve's resilient components were determined to be made of Buna-N.

C. Dates and Approximate Times of Major Occurrences:

July 16, 1996 A fire detector failed because of corroded
at 1406 EDT contacts and the area below the Unit 2 high
pressure turbine was sprayed down with
water from the fire protection system.

July 16, 1996 Operations personnel verified that no in
at 1420 EDT service equipment was affected by the
spraydown.

July 16, 1996 Engineering personnel surveyed the area and
at 1600 EDT found no apparent damage from the
spraydown. Subsequent to the spraydown
actions were taken to replace the failed
detector with a sealed moisture resistant
detector,

October 7, 1996 MCR operators observed the status indicator
at 1524 EDT lights changed for the No. 4 RCP seal
return flow control valve. Seal return
flow was verified to be in the normal range
with no change in indicated flow. A work
document was initiated to address the
condition.

October 11, 1996 The seal return low flow alarm annunciated
at 0312 EDT in the MCR for the Unit 2, No. 1 seal, on
the No. 4 RCP, and is followed by the RCP
standpipe alarm. The appropriate abnormal
operation procedure was entered and it was
determined that the RCP was required to be
removed from service within eight hours.

October 11, 1996 MCR personnel consulted with management and
at 0520 EDT began a controlled shutdown of Unit 2.

October 11, 1996 Reactor power had been reduced to
at 0826 EDT approximately 47 percent. The "B" main
feedwater pump was removed from service in
accordance with procedure. Operators
determined that an unexpected turbine
runback was in progress and that the
auxiliary feedwater pumps had started.

October 11, 1996 After consultation with the Shift Manager,
at 0827 EDT the operator at the controls initiated a
manual reactor trip. Emergency procedures
were entered for recovery from the manual
reactor trip. A feedwater isolation
occurred coincident with RCS low T sub avg
of 550 degrees Fahrenheit (F). Operators
observed that the loop 4 feedwater
isolation valve lost control board
indication.

October 11, 1996 RCS T sub avg drops below 547 degrees F
at 0835 EDT (normal no load T sub avg and in accordance
with procedure the MCR operators are
directed to take manual control of
auxiliary feedwater. Operators were unable
to take manual control of the MDAFW pump
level control valves. The MDAFW pump
controls were placed in the pull-to-lock
position to limit RCS cooldown. Auxiliary
feedwater control was maintained by manual
operation of the TDAFW pump level control
valves. Technical specification (TS)
limiting condition for operation (LCO)
3.7.1.2, Action b is entered. The lowest
RCS temperature reached was approximately
538 degrees F.

October 11, 1996 RCS T sub avg recovers to Mode 3 normal
at 0915 conditions.

October 11, 1996 The Unit 2, No. 4 RCP was removed from
at 0940 EDT service as required by procedure.

October 11, 1996 The MDAFW pumps are returned to service and
at 1044 EDT TS LCO 3.7.1.2, Action b is exited.

D. Other Systems or Secondary Functions Affected:

The turbine runback circuitry performs two functions: (1)
initiation of a turbine runback, and (2) start of the MDAFW
pumps with their level control valves

modulating open in automatic control, and a start of the TDAFW
pump with its level control valve traveling to full-open. The
turbine runback circuitry is actuated when two turbine impulse
pressure switches that are in series close with turbine impulse
pressure above 80 percent and one of the two feedwater pumps is
tripped. The runback circuitry is disabled when one of the
pressure switches opens after turbine impulse pressure drops
below 75 percent. Failure of the pressure switches resulted in
the runback circuitry being inappropriately actuated when a
main feedwater pump was removed from service at approximately
47 percent power.

E. Method of Discovery:

Subsequent to removal of the "B" feedwater pump from service, the MCR operators noted a decrease in turbine load, indicative of a runback condition.

F. Operator Actions:

Control room personnel promptly diagnosed the plant condition and took actions necessary to stabilize the unit in the hot standby condition (Mode 3).

After determining that a unexpected turbine runback was in progress, the operator at the controls, appropriately tripped the reactor. Subsequent to the trip, the Unit 2 MCR personnel proceeded through the actions described by the emergency procedures.

G. Safety System Responses:

The equipment associated with the event responded as designed with the exception of one of the feedwater isolation valves. During the event, a feedwater isolation signal was received on low T sub avg (RCS T sub avg trended below 550 degrees F). Feedwater isolation valves in loop Nos. 1, 2, and 3 closed upon receipt of the feedwater isolation signal. The loop No. 4 feedwater isolation valve lost control board indication. Subsequent to the transient, it was determined that the valve remained in the open position. The loop No. 4 feedwater regulator valve closed as expected and as designed isolated feedwater flow. Subsequent examination of the loop No. 4 feedwater isolation valve determined that the valve's position retention brake failed to release. The brake failure resulted in a locked rotor

condition and prevented the valve from traveling to the closed position. This resulted in the associated electrical power breaker tripping and the loss of control room indication.

As the transient progressed RCS T sub avg trended below 547 degrees F and in accordance with procedure the MCR operators attempted to take manual control of auxiliary feedwater to limit the cooldown. The runback condition prevented operators

from taking manual control of the MDAFW pump level control valves. With the failure of the turbine impulse pressure switches, the turbine runback circuitry (including the auxiliary feedwater system start) was sealed in preventing accident reset of the level control valves. After verifying adequate steam generator levels, the MCR operators placed the MDAFW pump controls in the pull-to-lock position to limit RCS cooldown. Steam generator levels were maintained by manual operation of the TDAFW pump level control valves. RCS T sub avg dipped to a low of approximately 538 degrees F.

III. CAUSE OF THE EVENT

A. Immediate Cause:

The immediate cause of the event (engineered safety feature and reactor protection system actuations) was the manual tripping of the reactor by the operator at the controls. This action was taken because of an unexpected loss of turbine load.

The loss of turbine load was caused by the malfunction of turbine impulse pressure switches. The switches failed to open contacts in the turbine runback circuit after turbine impulse pressure was reduced below the 75 percent level. This resulted in the automatic actuation of a turbine load reduction and the start of the auxiliary feedwater system when the "B" feedwater pump was removed from service. The pressure switches malfunctioned because of corrosion product buildup that was the result of water intrusion. Several months before the reactor trip, the area below the high pressure turbine was inadvertently sprayed by the high pressure fire protection system. The spraydown was the result of a failed fire detector. Immediately after the water spraydown, inspections were performed by Operations and Engineering support personnel and no indication of damage or affect to in service equipment was identified. Subsequent to the reactor trip, testing determined that spraydown water could have entered the

associated junction boxes and tracked along the cable directly to the pressure switch case without leaving any indication of water intrusion in the junction box.

The cause for the failure of the loop No. 4 feedwater isolation valve to close upon receipt of the feedwater isolation signal

was the malfunction of the position retention brake located on the valve's motor. The motor brake failed to release, preventing operation of the valve's motor operator. The brake failed to release because of corrosion product buildup that was the result of water intrusion. Unit 2 feedwater isolation valve stroke time-testing of the was performed in May 1996. The stroke times for the four valves were found to be well within the acceptance range. Maintenance history indicated that this specific valve had failed to operate on previous occasions because of corrosion product buildup in the brake.

B. Root Cause:

The root cause of the event was that inadequate field inspections were performed and inadequate corrective actions were taken. Surveys were performed of the sprayed down area to determine the impact to plant equipment. Individuals performing the surveys did not realize that water could have entered the pressure switch cases. As a result corrective actions taken for the spraydown event did not address water intrusion into electrical junction boxes or electrical instrumentation. Similarly, the actions taken for previous failures of the feedwater isolation valve brake have not adequately addressed the failure mechanism and adequate preventive actions were not taken.

C. Contributing Factors

Contributing to the event was the failure of a fire detector located under the high pressure turbine. The fire detector failed because of corroded contacts from exposure to condensate from the No. 1 steam sea] on the high pressure turbine. Following the failure of the fire detector, the No. 1 steam seal pressure was adjusted to stop the condensate out flow. Additionally, the fire detector was replaced with a moisture resistant, sealed detector,

IV. ANALYSIS OF THE EVENT

Safety systems performed as expected, except as noted below, and plant parameters responded as expected for the reactor and turbine trips. Main feedwater flow was terminated on the reactor trip. As designed, the Auxiliary Feedwater system started with the initiation of the turbine runback signal and steam flow continued to the

turbine- driven auxiliary feedwater pump. Because the runback signal prevented manual control of the MDAFW pump level control valves, operators placed the MDAFW pumps in the pull-to-lock position to limit RCS cooldown. As the transient progressed operators maintained steam generator levels by operation of the TDAFW pump level control valves. Steam generator levels remained within the expected range throughout the transient.

During the event response, Unit 2 RCS temperature trended below 540 degrees F and emergency boration was performed as required by emergency procedures. RCS temperature dipped to a low of approximately 538 degrees F. Calculations show that sufficient shutdown margin was maintained through out the transient. Final Safety Analysis Report and technical specification requirements were not violated.

During the transient, a feedwater isolation signal occurred and feedwater isolation valves for loop Nos. 1, 2, and 3 closed. The loop No. 4 feedwater isolation valve failed to close upon receipt of the feedwater isolation signal. The inability of the loop No. 4 valve to close is within the safety analysis for the design basis of the plant. Failure of this valve is acceptable since feedwater regulating valves, located upstream, provide the necessary isolation. The four feedwater regulating valves (one in each loop) closed as expected. These valves are the primary valves for isolation of feedwater for loss of coolant and non-loss of coolant accidents.

A low No. 1 seal return flow condition, on the No. 4 RCP, existed before the unit was tripped. Based on procedural guidance and stable RCP parameters (lower bearing temperature and No. 1 seal inlet and outlet temperatures), a controlled shutdown was initiated to remove the RCP from service and minimize potential damage to the pump seals. In accordance with procedural requirements and vendor guidance, the RCP was removed from service within the procedurally required eight- hour timeframe.

Based on the above analysis, the event described in this LER did not adversely affect the health or safety of plant personnel or the general public.

V. CORRECTIVE ACTIONS

A. Immediate Corrective Actions:

Control room personnel promptly diagnosed the plant condition and took actions necessary to stabilize the unit in the hot standby condition (Mode 3). After determining that an unexpected turbine runback was in progress, the operator at the controls manually tripped the reactor. Subsequent to the trip, the Unit 2 MCR personnel proceeded through the actions described by the emergency procedures.

The turbine impulse pressure switches were replaced. The new switches were tested, found to be acceptable and placed in service. Examinations were performed of other susceptible instrument- related electrical junction boxes in the Unit 2 turbine building and other plant areas for potential degraded conditions. Approximately 25 percent of the junction boxes in the turbine building and 15 percent of the junction boxes in the pumping stations (condenser circulating water and essential raw cooling water) were found to have experienced water intrusion. Any degraded conditions were evaluated for plant operational impact and corrected as necessary.

The failed feedwater isolation valve motor and brake assembly were replaced. The operation of the valve was tested, found to be acceptable and returned to service. The motor brakes on the other three Unit 2 feedwater isolation valves were inspected, and no problems were found. The Unit 1 feedwater isolation valves received an external visual inspection for potential moisture intrusion. The Unit 1 valve motor and brake assemblies were found to be in good condition. It was determined that the moisture intrusion condition was specific to the Unit 2, Loop No. 4, feedwater isolation valve.

B. Corrective Actions to Prevent Recurrence:

Actions recently taken such as: (1) providing root cause analysis training to appropriate Engineering personnel, (2) qualification of individuals as root cause lead investigators, (3) increasing Engineering awareness of maintenance and plant activities, and (4) increasing the sensitivity of Operations and Engineering personnel to lower threshold plant conditions by management monitoring and coaching in the field should improve cause determination and corrective action development.

The corrective action program has been strengthened regarding

root cause analyses. A standard format for reporting equipment root cause analyses has been developed and included in the corrective action program procedure. Additionally, management review, through the management review committee, has been added to the process to reinforce management expectations until desired results are achieved.

The Unit 2 trip and associated equipment failures have been reviewed for lessons learned. These lessons learned have been communicated to appropriate site personnel. Additionally, a design change was initiated for installation of water drip shields on the Unit 2, loop No. 4 feedwater isolation valve and the water drip shield was installed.

VI. ADDITIONAL INFORMATION

A. Failed Components:

There were two component failures, turbine impulse pressure switches, and motor-brake, associated with the event. The turbine impulse pressure switches were manufactured by Ashcroft, Catalog No. B761BXFSK3. The motor-brake was manufactured by Dings Company, model No. 6-74050-6S.

B. Previous LERs on Similar Events:

A review of previous reportable events identified one (50-327/92018) that was associated with water intrusion. Actions taken for that event would not have prevented the event described in this LER.

C. Additional Information:

The failed solenoid valve was replaced. The solenoid and seal water flow control valves were tested, found acceptable and returned to service. Other solenoid valves associated with Unit 2 operation were evaluated and replaced as necessary. Similar evaluations are in progress for Unit 1.

VII. COMMITMENTS

None.

37379-2000

R.J. Adney
Site Vice President
Sequoyah Nuclear Plant

November 12, 1996

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

TENNESSEE VALLEY AUTHORITY - SEQUOYAH NUCLEAR PLANT (SQN) UNIT 2 - DOCKET
NO. 50-328 - FACILITY OPERATING LICENSES DPR-79 LICENSEE EVENT REPORT
(LER) 50-328/96005

The enclosed report provides details concerning a manual reactor trip with feedwater isolation and auxiliary feedwater start as a result of an unexpected loss of load. This event is being reported in accordance with 10 CFR 50.73(a)(2)(iv) as a condition that resulted in a manual or automatic actuation of engineered safety features, including the reactor protection system.

Sincerely,

R. J. Adney

Enclosure
cc: See page 2

ATTACHMENT TO 9611220125 PAGE 2 OF 2

Enclosure
cc (Enclosure):
INPO Records Center
Institute of Nuclear Power Operations
700 Galleria Parkway
Atlanta, Georgia 30339-5957

Mr. R. W. Hernan, Project Manager
U.S. Nuclear Regulatory Commission
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852-2739

NRC Resident Inspector
Sequoyah Nuclear Plant
2600 Igou Ferry Road
Soddy-Daisy, Tennessee 37379-3624

Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323-2711

*** END OF DOCUMENT ***